



on Environment

U. S. Department of Energy

Bartlesville Project Office

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Until recently, DOE managed its oil and gas environmental research program through its Metairie Site Office in New Orleans, Louisiana. With the closing of this office, the program is now managed by the Bartlesville Project Office in Bartlesville, Oklahoma. This newsletter features several oil- and gas-related projects implemented through the Bartlesville Project Office.

The U.S. Department of Energy's (DOE's) oil and gas environmental research program encompasses both upstream and downstream projects. BDM-Oklahoma, Inc., as management and operating contractor of the National Oil Program, assists DOE in reaching its research objectives.

Primary DOE contacts for the program are David Alleman (918-337-4455), Rhonda Lindsey (918-337-4407), or Herb Tiedemann (918-337-4293) in the Bartlesville Project Office. Primary contacts for BDM-Oklahoma are Steve Jones (918-337-4528) or Jerry Simmons (918-337-4239). 



INJECTION WELL AREA OF REVIEW (AOR) VARIANCE

AOR BACKGROUND

The Safe Drinking Water Act (SDWA) of 1974 required the Environmental Protection Agency (EPA) to develop requirements for state programs to protect underground sources of drinking water (USDWs) from contamination by subsurface injection. EPA requirements address injection well construction, operation, monitoring, and reporting. For Class II (disposal and injection) wells, a 1/4 mile radius Area of Review (AOR) of active, idle, and abandoned wells must be conducted. Initially, pre-1982 Class II injection wells were excluded from AOR requirements. However, EPA plans to revise the regulations and include AOR requirements for these previously “grandfathered” wells.

WHAT ARE AOR VARIANCES?

A Federal Advisory Committee (FAC) recommended that AORs for previously exempt existing wells be performed within five years of the amended regulations. However, FAC recognized that conditions can exist that make it unnecessary to perform well-by-well AORs, allowing wells in a field, basin, trend, area, or portion thereof to be exempted from an AOR through a variance program. A variance can be granted because of the following conditions; the absence of USDWs, the reservoir is underpressured relative to the USDW, local geological conditions preclude upward

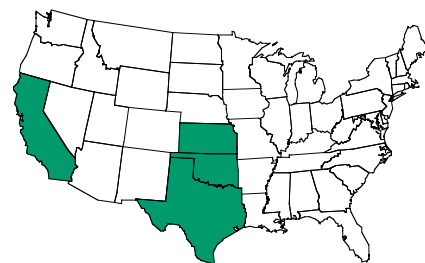
fluid movement that could endanger USDWs, or other compelling evidence.

WHY ARE AOR VARIANCES SIGNIFICANT?

Requiring AORs for all existing injection wells could create an unbearable burden of proof and cost for operators and state regulatory agencies. DOE estimates that industry savings due to avoiding maximum AOR costs for pre-1982 wells in all states could reach \$340 million. Costs for newly drilled wells and for individual states have not been estimated. A variance for a state could significantly reduce these anticipated costs. Demonstration of AOR variance methodology would also establish the potential value of the methodology to other states.

DEVELOPMENT OF STATE AOR VARIANCE PROGRAMS

DOE is developing statewide AOR variance systems in California, Kansas, Oklahoma, and Texas. Work includes: (1) identification of areas which may qualify for AOR variances, (2) correlate information from different databases, (3) risk-based pollution analysis, and (4) development of spatial analysis of injection well data in conjunction with other geographically referenced information.



AOR Variance Programs

DEMONSTRATION OF AOR VARIANCE METHODOLOGY

The University of Missouri-Rolla developed an AOR variance methodology under the sponsorship of API in coordination with the Ground Water Protection Council. With DOE support, the AOR variance methodology is being demonstrated in Texas, both in the East Texas field and in a nine-county area of the Gulf Coast.

In the East Texas field area, the principal and lowermost fresh water aquifer is the Carrizo-Wilcox aquifer. The zone of usable quality water is just above the base of the Wilcox. The principal oil reservoir, the Woodbine, lies 3,000 ft. below the base of the Wilcox. Pressure build-up analysis of an injectivity test indicated that, over the lifetime of the injection well, reservoir pressure would increase only 105 psi. A pressure of 173 psi is considered necessary to initiate upward flow of reservoir water into the aquifer. The pressure analysis provided grounds for an AOR variance, which the Texas Railroad Commission (TRRC) has approved. Industry cost savings are estimated at \$86 million from this single AOR variance.

STREAMLINING REGULATIONS

DOE's AOR and variance analysis program is a major element in the thrust towards regulatory streamlining. DOE, however, supports many other projects. An Outer Continental Shelf (OCS) Safety and Environmental Management Program (SEMP) demonstration project and a California Pipelines project represent prime examples.

SEMP, WHAT IS IT?

In response to safety and environmental concerns by the Minerals Management Service (MMS), the American Petroleum Institute and the Offshore Operators Committee developed RP75 [Recommended Practices for Development of a Safety and Environmental Management Program for Outer Continental Shelf (OCS) Operations and Facilities, May 1993]. RP75 details how producers operating on the OCS should develop a safety and environmental program. Under the SEM program, offshore producers are responsible for identifying potential hazards in the design, construction, and operations of drilling and production rigs and developing specific approaches to reduce the occurrence of accidents. In mid-1994 MMS requested that industry voluntarily adopt RP75.

WHY A SEM DEMONSTRATION PROJECT?

Many small and midsized independent producers have raised questions over the costs and methods for implementing RP75. DOE

and MMS believe that a prototype demonstration project performed by a smaller producer would answer operator questions. The demonstration project is MMS's initiative to provide offshore operators with a favorable alternative to "command-and-control" regulations. Through demonstration, the technical complexity, issues, and difficulties associated with SEM implementation by a smaller producer can be assessed. Demonstration experience will encourage other small or midsized producers to invest the time and resources to adapt RP75 procedures in their own operations. Additionally, producers' experience may impact future MMS decisions and rulemaking.

THE TAYLOR ENERGY SEM

In a competitive procurement, Taylor Energy of New Orleans has been selected to demonstrate SEM. Taylor Energy will implement SEM at five platforms over a 30-month period. Engineering and support services will be provided by Paragon Engineering. The project's objectives are to:

- Demonstrate the development and implementation of a SEM
- Determine the cost and effort for Taylor Energy to successfully implement a SEM
- Develop measures of effectiveness that will determine improvement/regression as a result of implementing the SEM

Paragon will assist in the development and evaluation of a SEM, including hazards analysis, safety

and environmental information, management of change, and safe work practices. Paragon will evaluate resource recovery, profitability, safety, environmental protection, and other areas. Experience and information developed through conducting the project will be documented in reports. SEM-related technology transfer efforts will focus on small and medium-sized OCS operating companies.

CALIFORNIA PIPELINES PROJECT

The California Fire Marshal is required to conduct an inventory and risk assessment of pipelines and gathering lines. DOE's California Pipelines Project will develop a database of pipeline information, assess their fitness and safety, and develop recommendations for pipeline safety, upgrades required for existing lines, construction standards for new pipelines, and incentive programs to repair, improve, or upgrade existing pipelines. The effort, which began in May 1995, should be finished in mid-1996.



Illustration courtesy of EDM Services, Inc.

DOWNSTREAM RESEARCH

DOWNSTREAM — REDUCING ENVIRONMENTAL BARRIERS

The U.S. refining industry is facing increasingly severe regulations regarding environmental issues. This comes at a time when refiners are experiencing complex processing requirements and poorer quality of feedstocks. These demands must be met economically, while still producing quality transportation fuels using environmentally acceptable refinery processes.

One of the objectives of DOE's downstream environmental program is to reduce the barriers to efficient refining placed on independent refiners by environmental regulations. As a part of this program, BDM-Oklahoma is cooperating with an independent refiner to identify major environmental barriers and develop solutions which will be of general value to the refining industry. NIPER is also cooperating with the Petroleum Environmental Research Forum to identify areas where research efforts will be of most value.

DOWNSTREAM — REFINERY WASTEWATER TREATMENT

One area of current interest is the treatment of refinery wastewater. Wastewater streams in a typical refinery may contain small quantities of many components. These components, although present in low concentrations, may have a dramatic impact on wastewater

treatment facilities. One program objective is to improve the reliability of ammonia nitrification in wastewater treatment facilities by correlating contaminant concentration with nitrification rate. BDM is cooperating with an independent refiner to conduct a sampling and analysis program of wastewater from various refinery sources. Preliminary analyses of these samples are being made using solvent extraction of the wastewater followed by gas chromatographic analysis of the extract.

NIPER TESTS CALIFORNIA REFORMULATED GASOLINE

California's new Phase 2 reformulated gasoline is being tested by the emissions testing facility at the National Institute for Petroleum and Energy Research (NIPER) in Bartlesville, Oklahoma. The new

gasoline is scheduled for introduction in March 1996, and is currently being tested in California for lubricity characteristics, effect on plastics and elastomers, and possible performance issues. The NIPER project will assess the fuel's long-term effect on vehicle emissions by conducting tests on five popular 1994 (Table 1) model vehicles that have accumulated approximately 20,000 miles in California. Results from 30,000-mile test runs on the California Phase 2 gasoline will be compared to baseline emissions testing with federal reformulated gasoline. Initial tests under Federal Testing Program standards indicate an average 44% reduction in non-methane organic gases and an average 25% reduction in carbon monoxide for the new California gasoline compared to the federal reformulated blend.

Table 1 1994 Model Vehicles in California Test Program

Make/ Model	Engine Displacement, liters	Mileage
1994 Toyota Camry	2.2	18,096
1994 Honda Accord	2.2	20,424
1994 Ford Taurus	3.0	22,001
1994 Chevy Lumina	3.1	29,492
1994 Nissan Maxima	3.0	21,153

UPSTREAM RESEARCH

MICROBIAL TECHNIQUE USED FOR GROUNDWATER REMEDIATION

In both the remediation of contaminated aquifers and the production of oil the goal is to remove specific compounds from the pore spaces of saturated porous media. Unfortunately, traditional methods for treating contaminated aquifers and for primary oil recovery leave 20–50% of the target substances behind. BDM Environmental is developing a more efficient system to remove contaminants or oil and leave water behind.

New microbial enhanced hydrocarbon recovery methods are expected to increase productivity and function in the remediation of contaminated water. BDM Environmental is developing methodologies to test the effectiveness of microbial enhanced hydrocarbon recovery methods in contaminated aquifers.

The process under investigation has four steps:

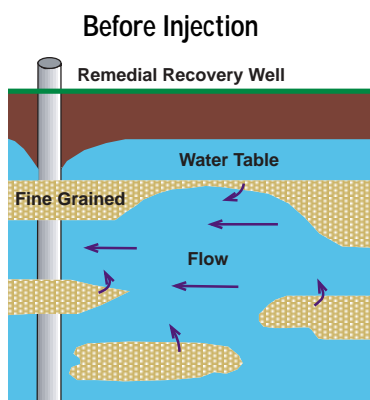
1. Inject microbes that manufacture surfactants and mobilization agents. These microbes flow into the higher permeability zones from the injection well to the production well.
2. Inject microbes that form polymers and or biomass to plug the high permeability zones. Flow is channeled through lower permeability zones where most of the residual contamination remains. Hydrocarbon concentration in produced water increases as the contamination zones in lower permeability strata begin to flow.
3. Repeat injection of surfactant microbes. This step helps

release hydrocarbons in finer-grained units, resulting in increased hydrocarbon concentration in the produced water. After this step the vast majority of recoverable hydrocarbons have been removed.

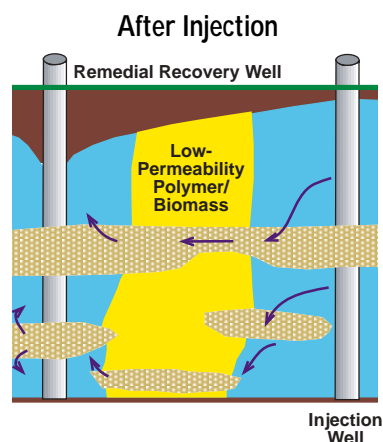
4. Inject microbes into all wells and allow the microbes to set up, encapsulating the hydrocarbon contamination. The fourth step is done to ensure that hydrocarbons are not continuing to be released to impact water use. The entire contaminated area is plugged with polymers or biomass.

This multistep method more effectively extracts oil and removes contaminants from the environment.

Upstream Examples



Coarser-grained units have been swept of most contaminants, while the finer-grained units continue to contribute contaminants to the aquifer.



In the ideal injection strategy, polymers and biomass do not set up immediately adjacent to the production or injection well. Flow is directed through the lower-permeability zones where the majority of the residual contamination resides.

TECHNOLOGY DEVELOPMENT/PRODUCTS

DOE partners with private industry, academic/university research groups, operators, and others to perform research directed toward developing new or improved environmental technologies/products. The following projects illustrate DOE's product-oriented research.

PRIVATE INDUSTRY

Membrane-Based Process for the Treatment of Oily Waste Waters, Bend Research.

Bend Research developed a laboratory-scale economical oily-water-treatment system based on reverse osmosis membrane technology. A thin-film-composite membrane over a solvent-resistant coating on a solvent-resistant hollow fiber was created. Oily waste travels down the inside of the hollow fiber. In laboratory tests, more than 90% of oily water was cleaned suitable for discharge, while the remaining 10% could be recycled or properly disposed of. If larger-scale field tests are successful, application of the treatment system will reduce oil production costs by reducing the volume of waste water for which disposal is required.

Cyclocranes to Support Drilling and Production in Wetlands Areas, Mission Research.

This project evaluated the potential use of cyclocraft and cyclocranes for oil and gas operations in wetlands. The study found (1) cyclocraft operations in wetland areas appear to be very practical

and should result in a high level of reliability, (2) required payloads of 45 tons are well within the cyclocranes' capability, (3) cyclocraft has potential for being more economical than other airborne systems, and (4) environmental impact is projected to be less than other wetlands options. Although significant investments would be required, the technology is well established and risks associated with development are clearly understood and are both low and acceptable.

ACADEMIC/UNIVERSITY RESEARCH

Hydrocyclone Development Consortium, Michigan State University.

Work in this industry consortium was designed to develop a new class of hydrocyclones to remove a light "dispersed" phase from a "heavy" continuous phase for the removal of dispersed oil from water. A commercial prototype from patented technology was being developed to remove small amounts of dispersed oil (< 3,000 ppm) from water. Potential applications include cleaning oily water on offshore platforms, bilge and ballast water on ocean vessels, and other waste streams.

Cost-Effective Environmental Compliance Technology for Stripper Well Brines, Pennsylvania State University.

This study developed and pilot-tested a brine treatment/discharge

methodology for treating low-volume discharges from Appalachian basin stripper gas wells. The product includes a computer software package enabling design parameters to be adjusted for specific brine discharges. Application of a portable water treatment system and the computer software has been demonstrated to Appalachian basin operators.

MAJOR OIL COMPANY RESEARCH

Developing a Cost-Effective Environmental Solution for Produced Water and Creating a "New" Water Resource, ARCO Western Energy.

This project demonstrates the performance and reliability of various technologies for removal of soluble oil from produced water. Equipment requirements include: (1) ability to operate at low pressures, (2) low sensitivity to fluctuations in flow and inlet oil concentration, (3) light and compact construction, and (4) modular design. The project is evaluating the feasibility of converting produced water into a potable water resource, while still being cost competitive with new water resources. The conversion of this byproduct of oil production could provide a significant new source of potable water for water-short California.

TECHNOLOGY TRANSFER/OUTREACH

Environmental outreach includes cosponsored workshops, publications and reports, and papers for appropriate technical societies. Publications and reports provide in-depth documentation of DOE-sponsored research, while papers present much of the same information in compact, industry-friendly format.

RECENT PUBLICATIONS/REPORTS

Analysis of Environmental Constraints on Expanding Reserves in Current and Future Reservoirs in Wetlands: Final Report (1995), MT91004-1, Harder, B.J., Louisiana State University, Baton Rouge, LA.

Characterization of Oil and Gas Waste Disposal Practices and Assessment of Treatment Costs: Final Report (1995), MT92007-9, Adewumi, M.A., et al., Pennsylvania State University, University Park, PA.

Geologic, Geochemical, and Geographic Controls on NORM in Produced Water from Texas Oil, Gas, and Geothermal Reservoirs: Final Report (1994), MT92011-12, Fischer, R.S., Bureau of Economic Geology, University of Texas, Austin, TX.

Produced Water Discharges in the Gulf of Mexico: Background Information for Ecological Risk Assessments (1995), Meinhold, A.F., et al.,

Brookhaven National Laboratory, Upton, Long Island, NY.

Wetland Mitigation Banking for the Oil and Gas Industry: Assessment, Conclusions, and Recommendations: Final Report (1994), SEWM-53, Wilkey, P.L., et al., Argonne National Laboratory, Chicago, IL.

Wetland Treatment of Oil and Gas Well Wastewaters: Final Report (1995), MT92010-10, Kadlec, R.H., and K.R. Srinivasah, University of Michigan, Ann Arbor, MI.

TECHNICAL PAPERS

SPE/EPA E&P ENVIRONMENTAL CONFERENCE, MARCH 1995, HOUSTON, TX

SPE 29696 *Characterizing Costs and Benefits of Uncertain Future Regulatory Requirements on the U.S. Natural Gas Industry.*

SPE 29707 *Impacts of Environmental Regulations on Future Resource Development in Louisiana Wetlands.*

SPE 29708 *Economic Impact of Potential NORM Regulations.*

SPE 29709 *Geologic, Geochemical, and Geographic Controls on NORM in Produced Water from Texas Oil, Gas, and Geothermal Reservoirs.*

SPE 29724 *Delineation of Biological Impact and Recovery of Selected Produced Water Discharges in Inshore Louisiana.*

SPE 29727 *Naturally Occurring Radioactive Materials Associated with Produced Water Discharges from Production Platforms in the Northwestern Gulf of Mexico.*

SPE 29728 *Health Risk Assessment for Radium Discharged Offshore in Produced Water.*

ARTICLES

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